RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #3

Examination of Message Error Rates for UAT Uplink

Presented by Chris Moody and Jeff Giovino

SUMMARY

Examination of Message Error Rates for UAT Uplink

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SC186 WG 5

April 2001

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Objective/Background

- **Determine the Message Error Rate requirement for the UAT General Purpose Uplink message**
  - **no documented requirements guidance as for ADS-B**
  - **guidance is needed to assess performance in the expected interference environment**
- **Lacking quantitative requirements, we make a qualitative assessment for graphical weather data as encoded for Capstone/SF21**

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Assumptions and Conditions for Assessment

- A single ground station is assigned 1 of the 32 available UAT Ground Uplink slots
- "APDUs" with encoded NEXRAD wx are packed into UAT uplink message payload
  - NEXRAD product extracted from national mosaic for 250 nmi radius of ground station
  - uses a run length encoding on a globally referenced grid matched to NEXRAD sensor resolution
  - entire product conveyed as a "loop" of APDUs transmitted over many uplink messages.
  - Mosaic updated at nominal 5 min rate at source

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Assumptions and Conditions for Assessment (Concluded)

- **Messages simulated convey only the NEXRAD precipitation image**
  - **no other types of APDUs (products) are part of this simulation**
- **Simulate random occurrence of errors in message uplink stream**
- **Compare rendered image under error conditions to baseline (perfect channel)**
  - **after first loop**
  - **after redundant second loop**

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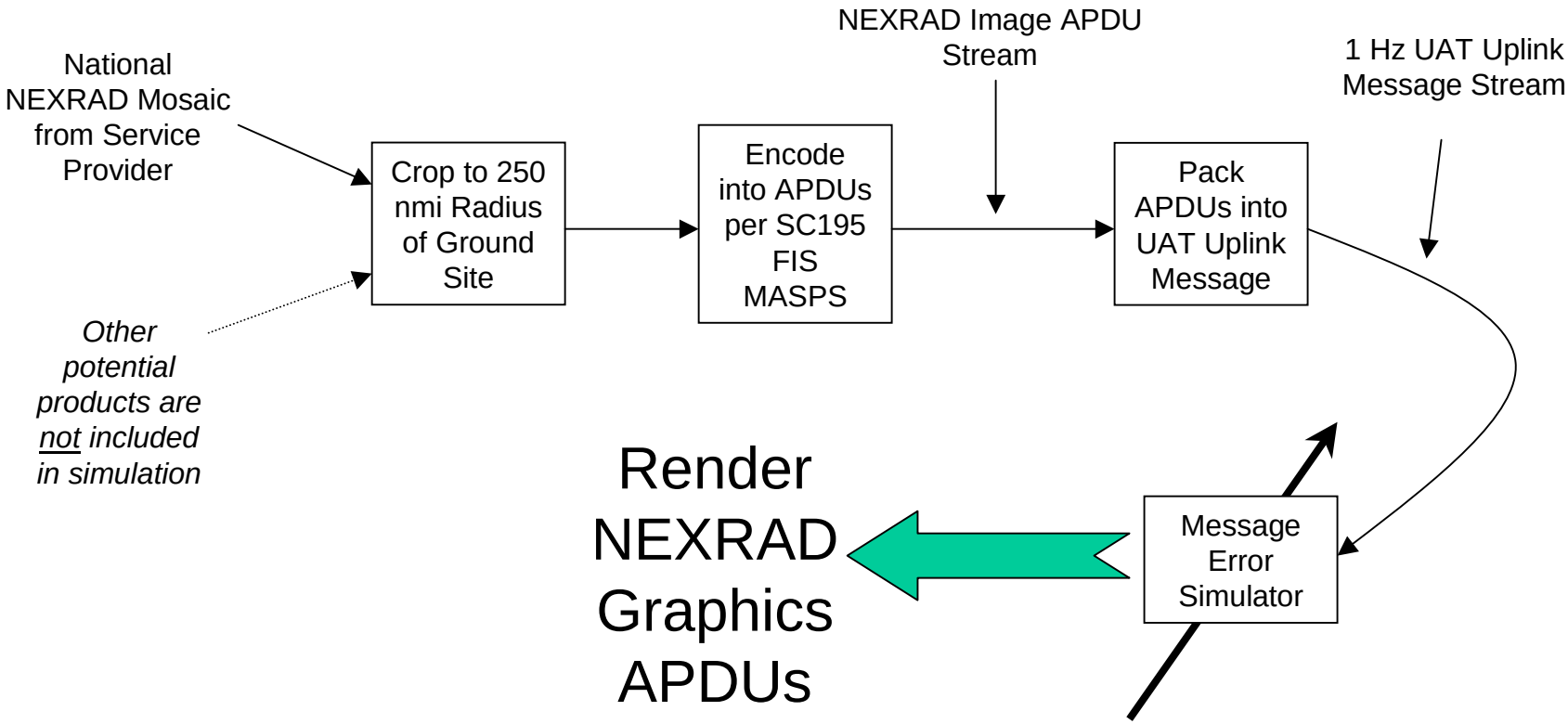
Uplink Process for Simulated MER Assessment



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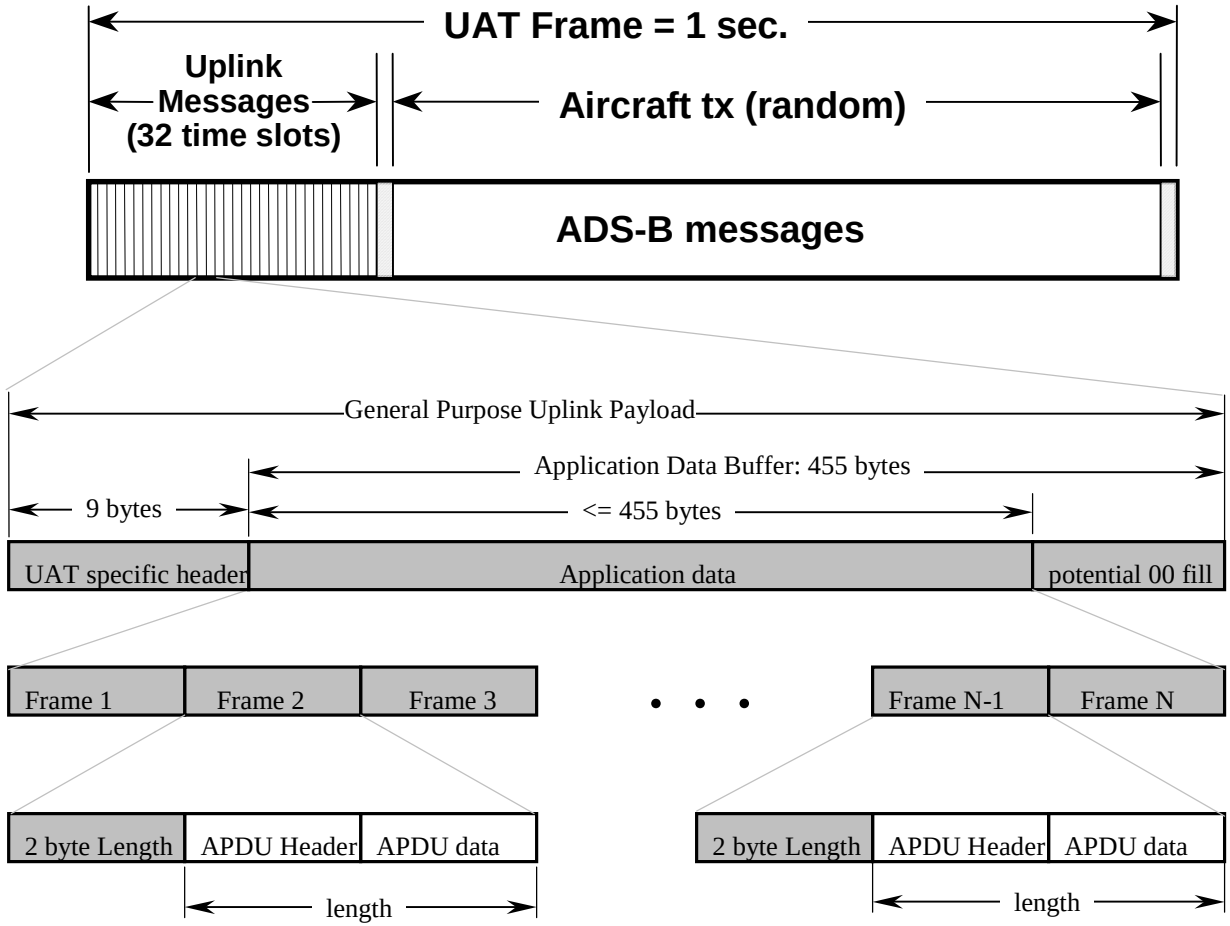
Uplink Elements and Hierarchy



Shaded boxes represent proposed scope of MOPS

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NEXRAD Composite Reflectivity: National Mosaic

Data Source: WSI Inc.

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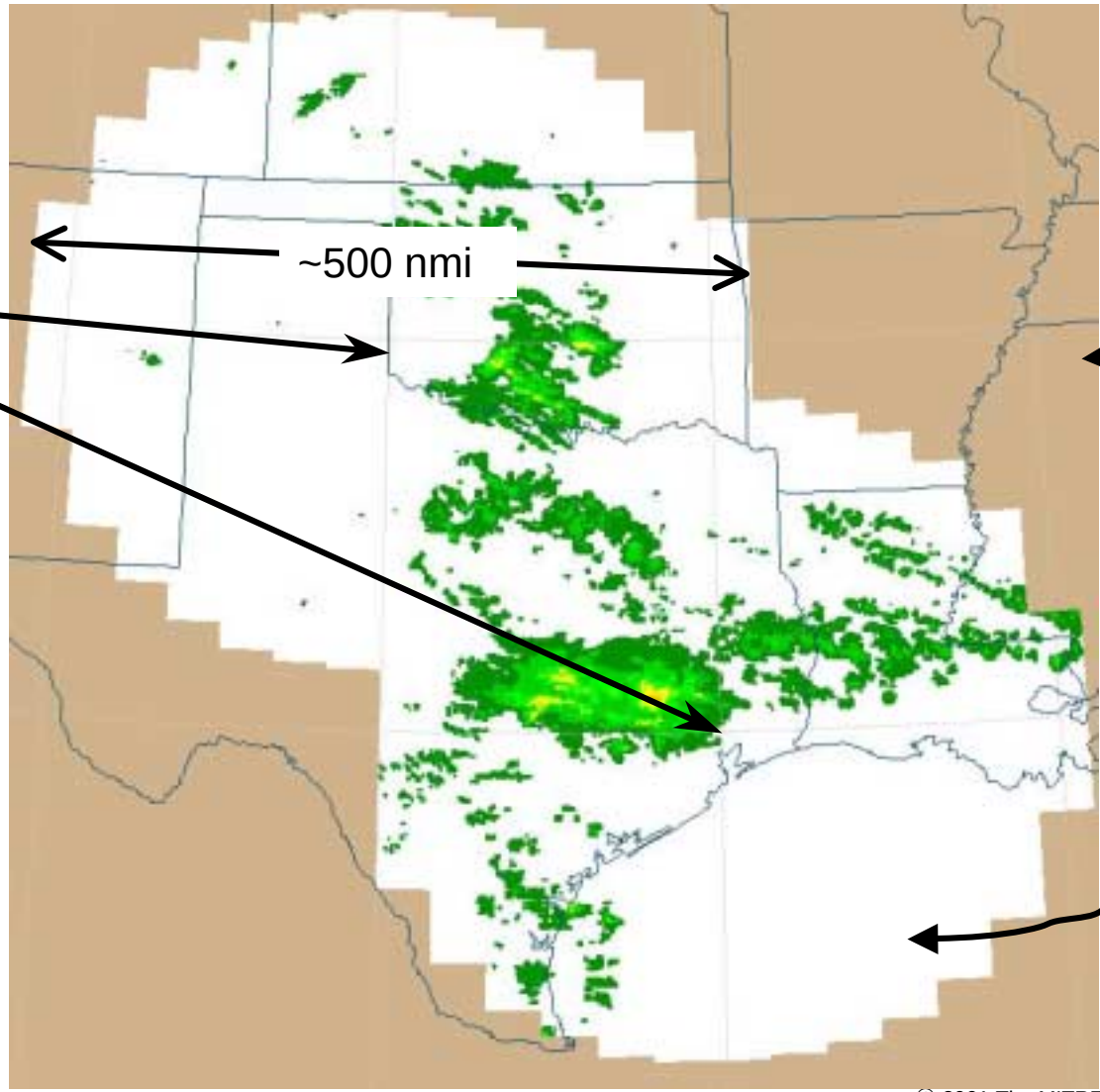
National Mosaic Cropped for Uplink by 2 Example Ground Stations



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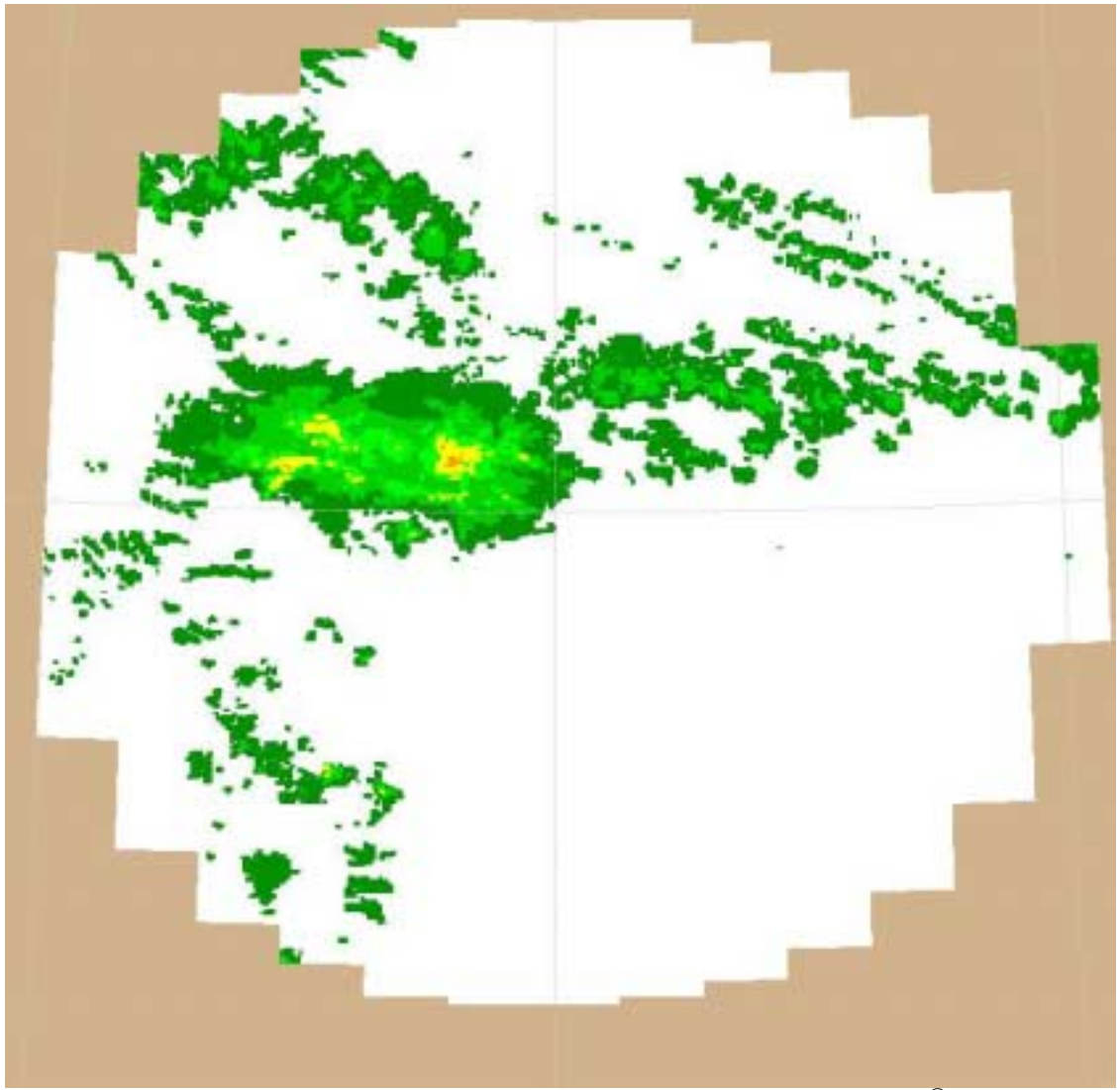
Baseline Image from Single Ground Station (Perfect Channel)



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Baseline Image Statistics

- **37 UAT Uplink Messages required to convey this image (per loop).**
- **Average of 19 APDUs are packed into each Uplink Message (range: 10-39)**
- **Covers 250 nmi radius of ground station--gives reasonable “look ahead” to flight crew.**
- **Image is moderate complexity (related to storm size/intensity). More complex would require more Uplink Messages to complete the loop.**

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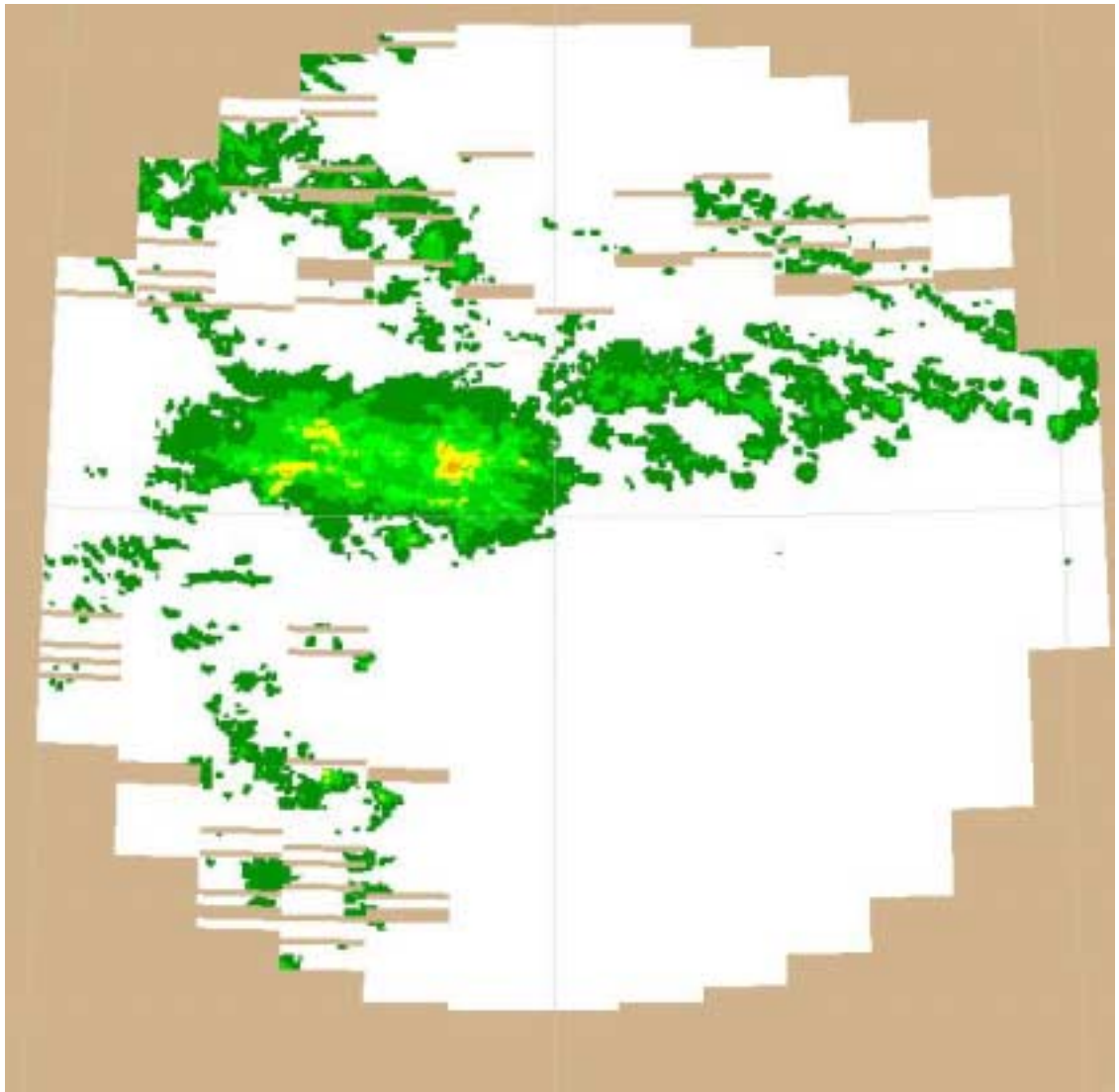
Rendered Image at 10% MER--after 1st Loop



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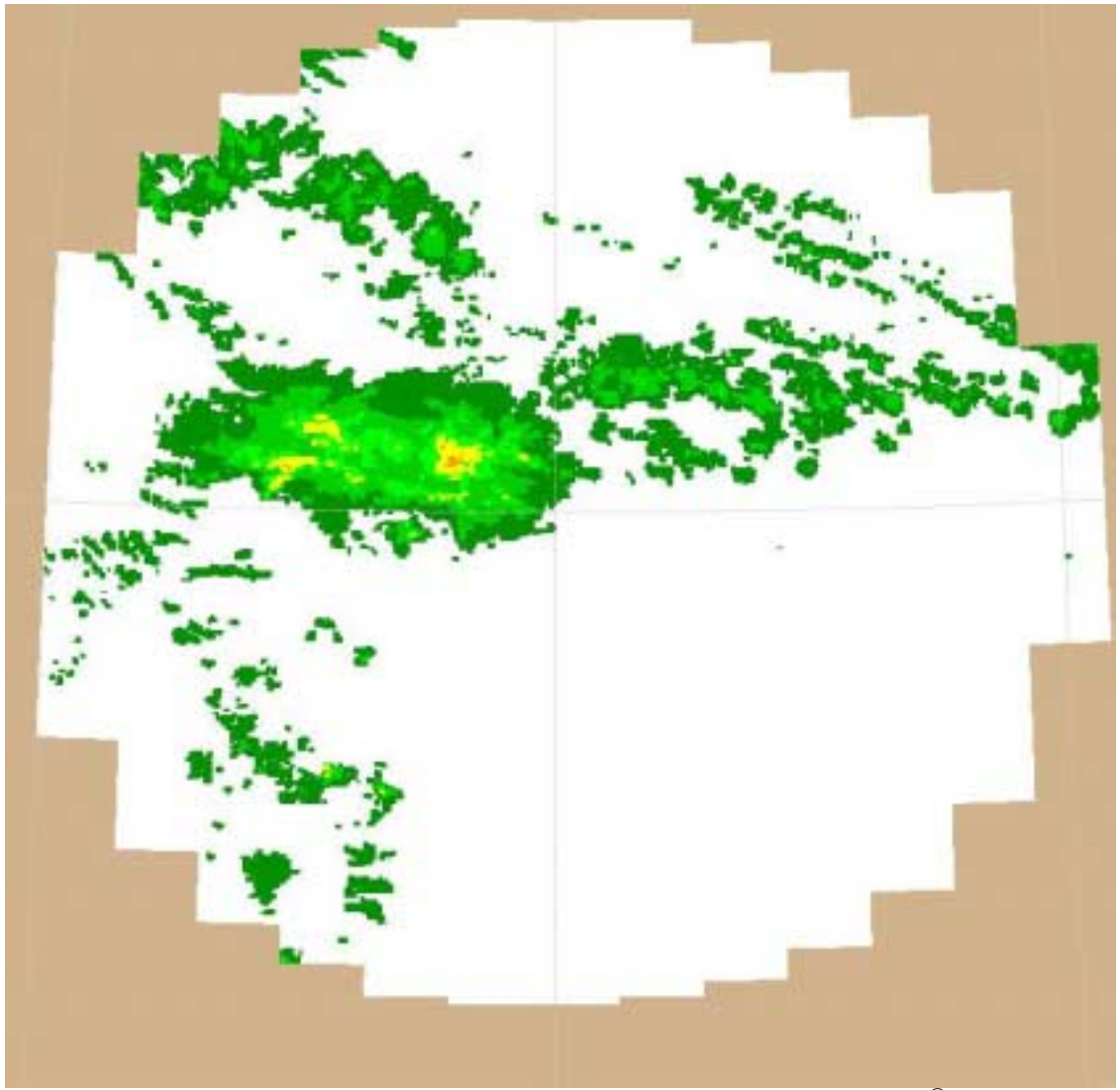
Rendered Image at 10% MER--after 2nd Redundant Loop



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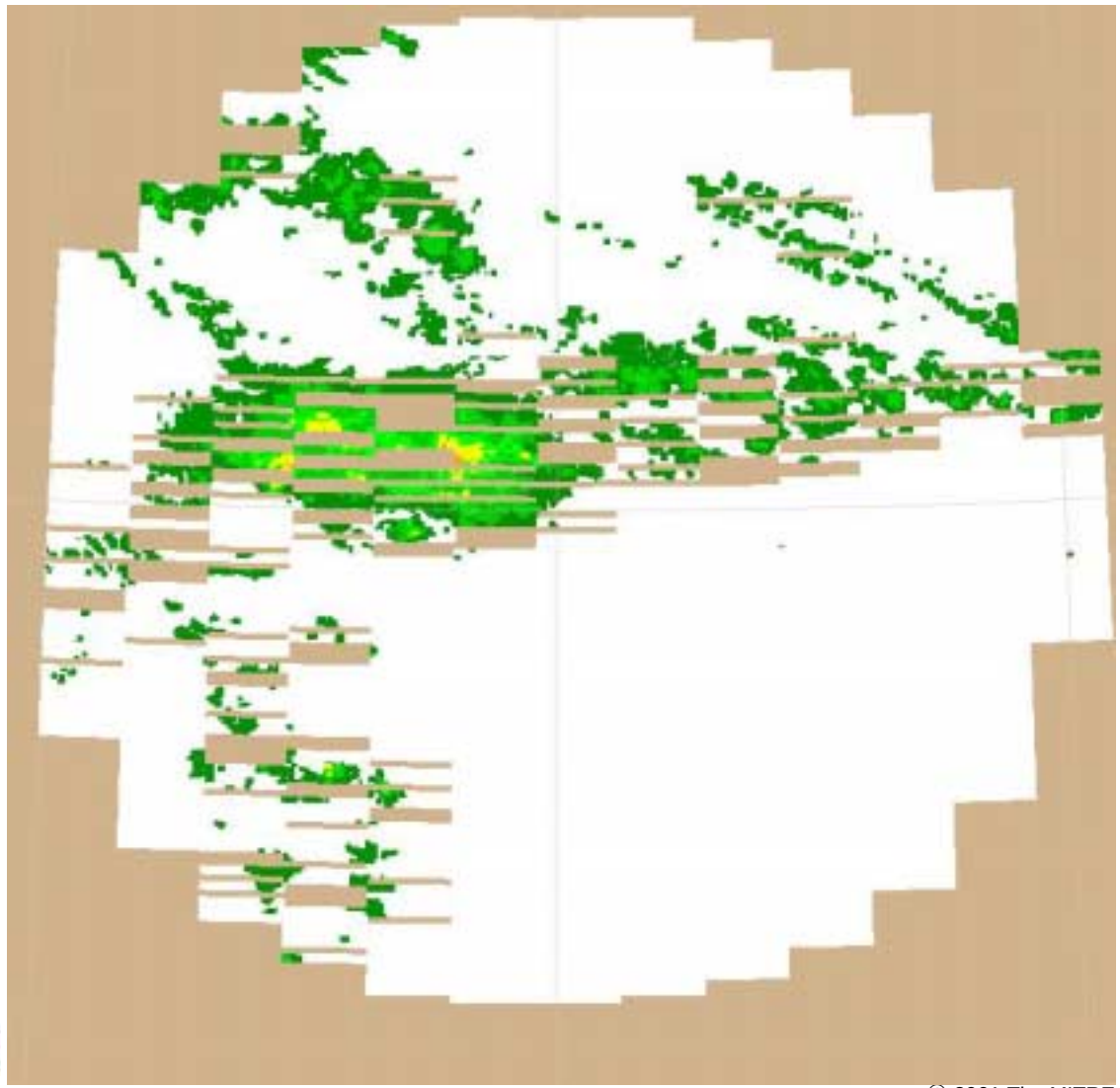
Rendered Image at 25% MER--after 1st Loop



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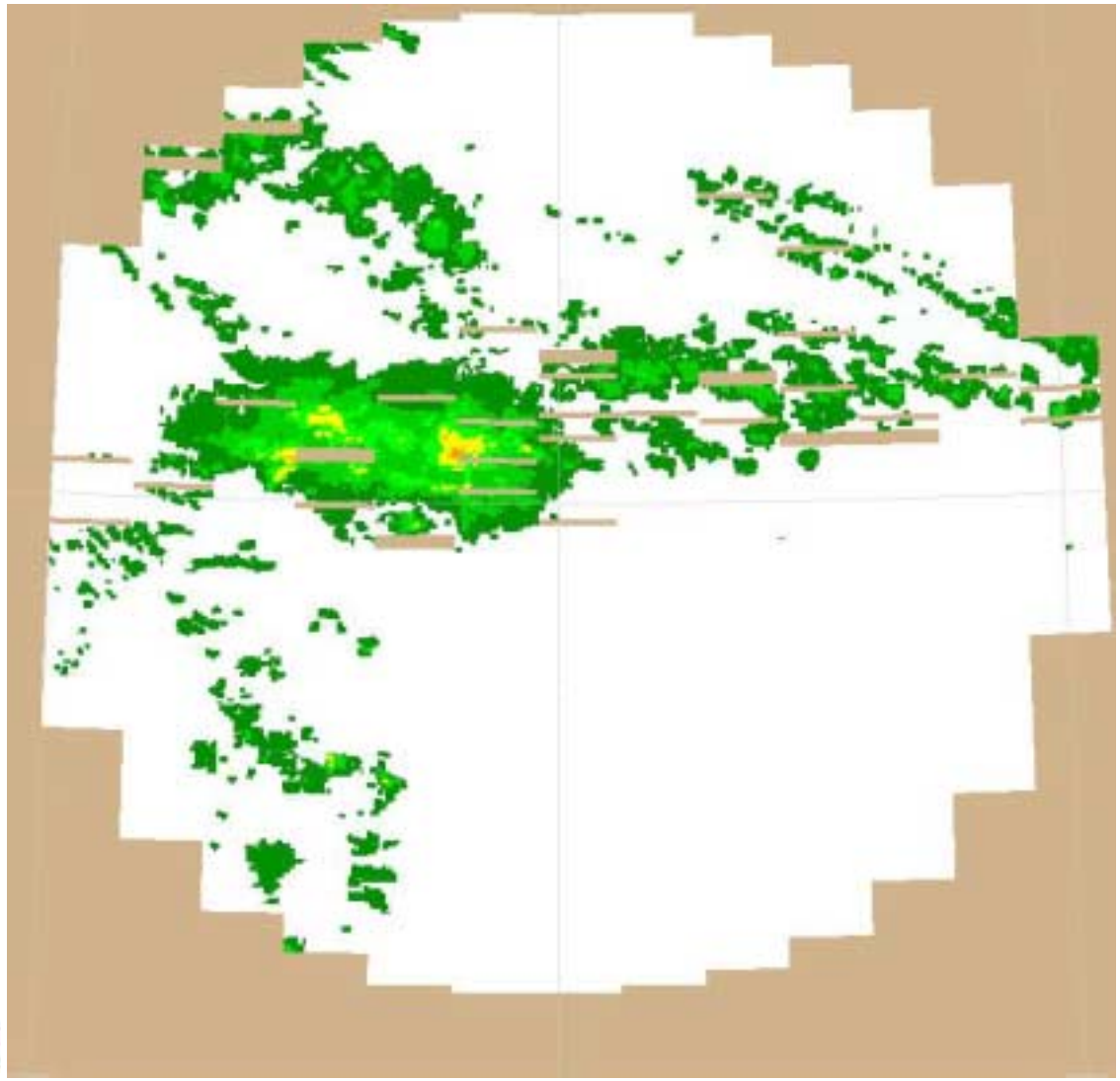
Rendered Image at 25% MER--after 2nd Redundant Loop



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Rendered Image at 50% MER--after 1st Loop

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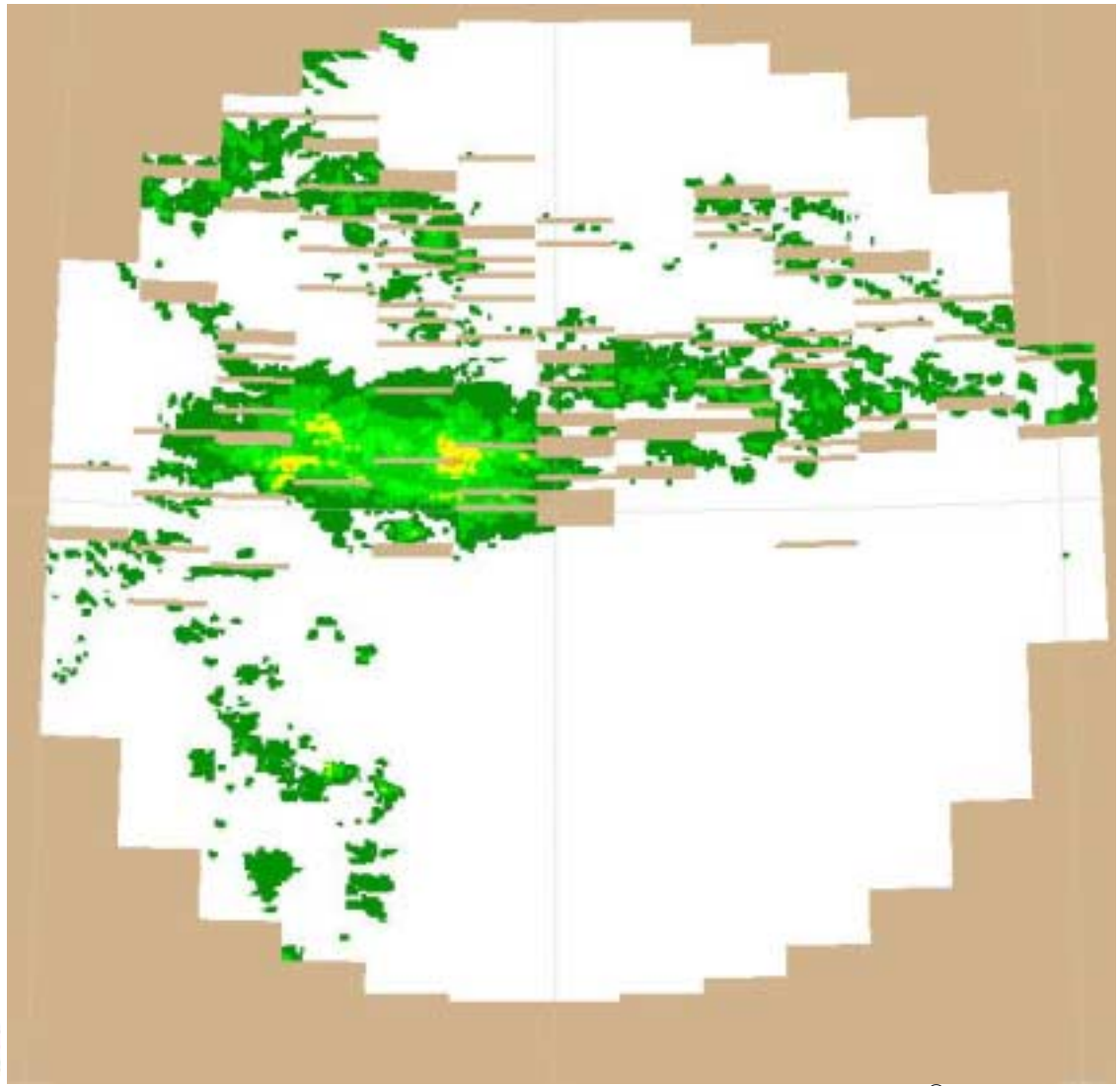
Rendered Image at 50% MER--after 2nd Redundant Loop



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Conclusions

- **Loop repetitions can compensate for message errors--at expense of bandwidth that could be used for other products**
- **Based on this NEXRAD encoding procedure, MER greater than 10% will be noticeable, and MER greater than 25% could reduce pilot confidence in the system**
- **We have no idea what other products we may eventually want to uplink--so we should be careful not to set the bar too low!**

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Recommendation

- **Planning for an Uplink MER of around 10% appears to be a prudent compromise:**
  - **allows for some interference tolerance**
  - **provides high quality/high confidence NEXRAD image**
  - **preserves capability for conveying future--potentially demanding--products/services using the UAT General Purpose Uplink Message**

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